CONTINUOUS AUTOMATIC BEAMHOUSE PROCESSING
I. DESIGN OF EQUIPMENT*

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Abstract

An automated process for preparing cattlehides for tanning is described in which brined cattlehide sides are manually placed on a feed conveyor and automatically processed through two soaking steps, a chemical unhairing step, mechanical unhairing and refleshing, and automatic splitting. The salient features of the process and of the mechanical parts of this line are discussed and augmented by photos of the pilot plant.

Introduction

Leathermaking is a prehistoric art. Its methods of production have been improved over millenia and have reached a high degree of sophistication. Leather manufacture has not, however, acquired the degree of automation typical of most other modern processes primarily because of the uneven shape and irregular size of the raw material, the hides. This was one reason that about 10 years ago it was feared that leather might be replaced by polymers which permit automation not only during their production but also during their further processing into finished articles.

Leather itself has too many unsurpassed attributes to ever succumb entirely to substitutes. The current technology for processing it, however, puts the tanning industry in most industrial countries at a disadvantage in competing for labor with other domestic industries and in selling its products in the international market because tanners in underdeveloped countries often enjoy considerable Government subsidies, and/or lower labor costs. The problem is further aggravated by the fact that tanners in the developed countries have to meet more stringent guidelines for treating their liquid and solid wastes. It is no wonder, therefore, that the proportion of domestic hides processed by U.S. tanners has been declining steadily, reaching less than 50 percent in recent years, while im-

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port of leather and leather goods has steadily increased and is responsible for a yearly deficit of 3 to 5 billion dollars in the balance of payments (1).

The initial step in leathermaking, the beamhouse operation, includes most of the dirtiest and labor-intensive steps in the process. Consequently, attempts have been made recently to introduce improvements in this area of the tannery. After World War II, most tanneries slowly switched from hair saving and splitting out of lime to hair burning and splitting in the blue. This reduced the labor problems somewhat, but added to pollution problems by increasing the BOD discharge of the liquid waste stream by 1/3 and the COD by 1/2. In addition, the chrome content of solid wastes was also significantly increased.

Recognizing the need for a more drastic change in beamhouse processing, Heidemann (2) developed a continuous process for unhairing hides in which fresh or presoaked, salted hides are treated with strong solutions of sodium sulfide that quickly burn off the hair, and then the hides and remaining sulfide are oxidized with sodium peroxide or sodium chlorite. This process incorporates most of the advantages of hair saving and yields a grain split of more uniform thickness than does conventional splitting out of lime. But it still requires a great deal of manual handling.

With the primary objectives of reducing pollution loads and labor requirements, this research was undertaken to develop a process and equipment for continuous automatic preparation of cattlehides for tanning.

The Continuous Automatic Beamhouse Process

The proposed process described in this paper is fully automatic and continuous. It includes a rapid unhairing step utilizing high sodium sulfide concentrations. In addition, the process introduces the following features: 1. A system of three transport conveyors which carries the hides through all mechanical and chemical operating steps including soaking, unhairing, mechanical hair removal and fleshing, and splitting; 2. Provisions for automatic, continuous mechanical unhairing and fleshing; and 3. A feeder/splitter arrangement for automatic, continuous splitting.

As demonstrated by Heidemann (2), unhairing of fresh hides can be accomplished readily. Sharphouse (3) and del Cueto (4) have shown that unhairing at high salt concentrations is feasible, although it occurs at a much slower rate. Our own research has demonstrated that rapid unhairing of brined hides can be performed after the salt content on the surface of the hide has been reduced.

Rapid unhairing of hides in the presence of salt is, therefore, one of the key elements in the development of this automated beamhouse process. Preliminary tests revealed that by using a 4 percent (W/W) commercial sodium sulfide solution, unhairing can be accomplished in less than 10 min if it is preceded by two soaking steps of the same duration, employing salt concentrations of 10 percent and 3 percent, respectively. Thus the wet operations of the process were designed to be carried out in three vats, the first containing about 10 percent salt, the second about 3 percent salt, and the third about 7 percent salt plus about 7 percent commercial sodium sulfide. The salt in the unhairing vat has the effect of slowing down the unhairing rate and minimizing hide-swelling, thus assuring a more uniform thickness during splitting.

A second key element of continuous beamhouse processing is the development of an automatic hide-splitting machine. A splitting system was devised in which the hide was introduced vertically to the splitter, thereby using gravity for feeding the hide and for removing the splits.

In addition to alleviating the two very important problems of labor and waste treatment, a continuous beamhouse operation has many other direct and indirect potential benefits. These include automatic measurement of hide area; visual inspection and grading; more uniform splitting; shorter processing times; more efficient utilization of drums or hide processors; savings in energy, water, and chemicals; and improved leather quality. Its widespread adoption by the domestic industry would also be expected to favorably affect the international balance of payments.

Loading and Chemical Operations (Figure 1). At the start of the line, two operators remove one hide at a time from an automatically leveled pallet and place the hide carefully centered on the feed conveyor while its conveyor belt is stationary (Figure 2). After a pause of approximately 15 sec, the feed conveyor starts and loads this hide onto one of the hide carrier bars of conveyor #1. While

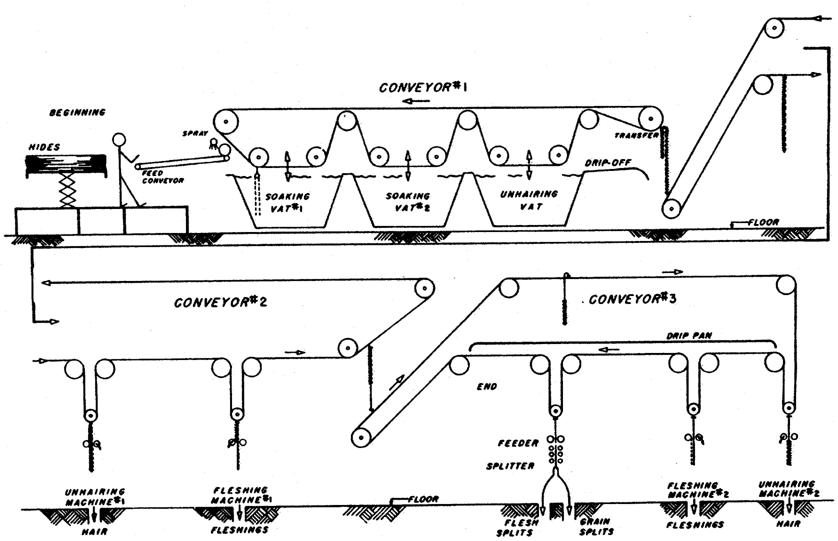

FIGURE 1. — Overall schematic of the continuous automatic beamhouse.

this hide is being loaded, a spray that utilizes the overflow water from the first soaking vat (10 percent salt solution) thoroughly wets the hide in order to remove the crystalline salt on its hair side. Immediately thereafter, a dewatering roll squeezes the hide. Meanwhile, the operators ready the next hide by unfolding it and shaking the loose salt from it. During the automatic loading, the hides are draped over a bar as they are being submerged in the first soaking vat. In order to prevent them from sliding off their bars while being agitated and conveyed fully submerged through the vats, the hides are gently clamped at each end in a way

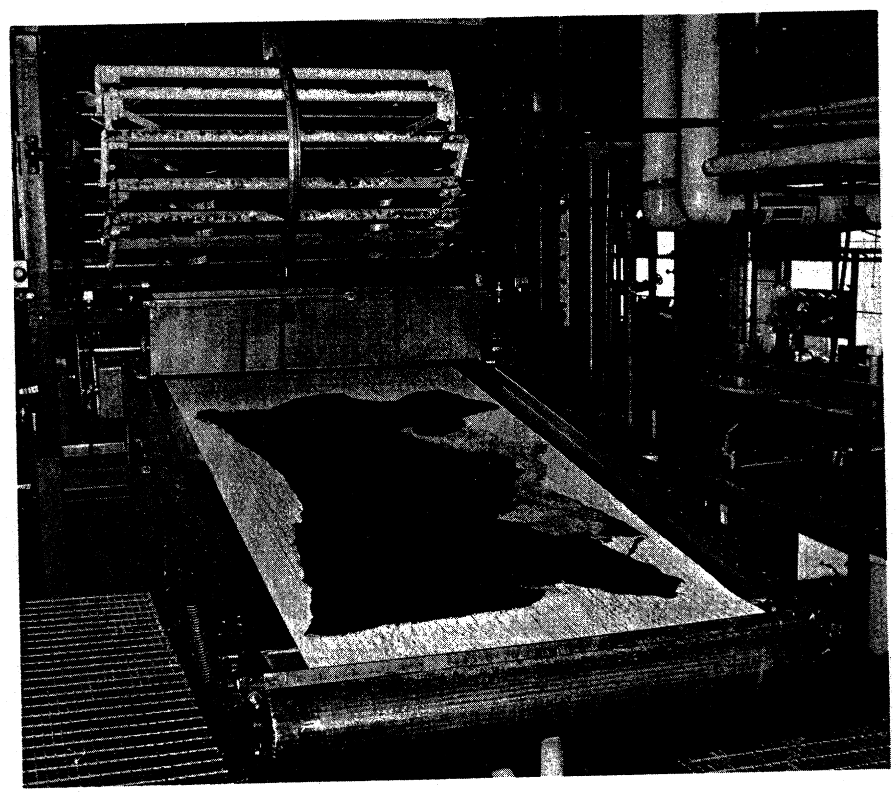

FIGURE 2. — Feed conveyor.

that does not interfere with soaking and unhairing. [A patent application for the automatic loading operation has been filed and copies of the application are available for those interested in a more detailed description (5)]. Spaced 6 in. apart, the hides slowly move at a nominal speed of 1 fpm through the soaking vats (Figure 3), and the unhairing vat. Agitation in all baths is provided by pneumatically driven arms that rhythmically raise and lower the conveyor chain and the hides. When the hides enter the unhairing bath, where the sodium sulfide concentration is about 4 percent, the hair pulps quickly. Upon emerging from the unhairing vat, the hides are drained for a few minutes to remove excess unhairing solution, and then they are transferred to the second conveyor.

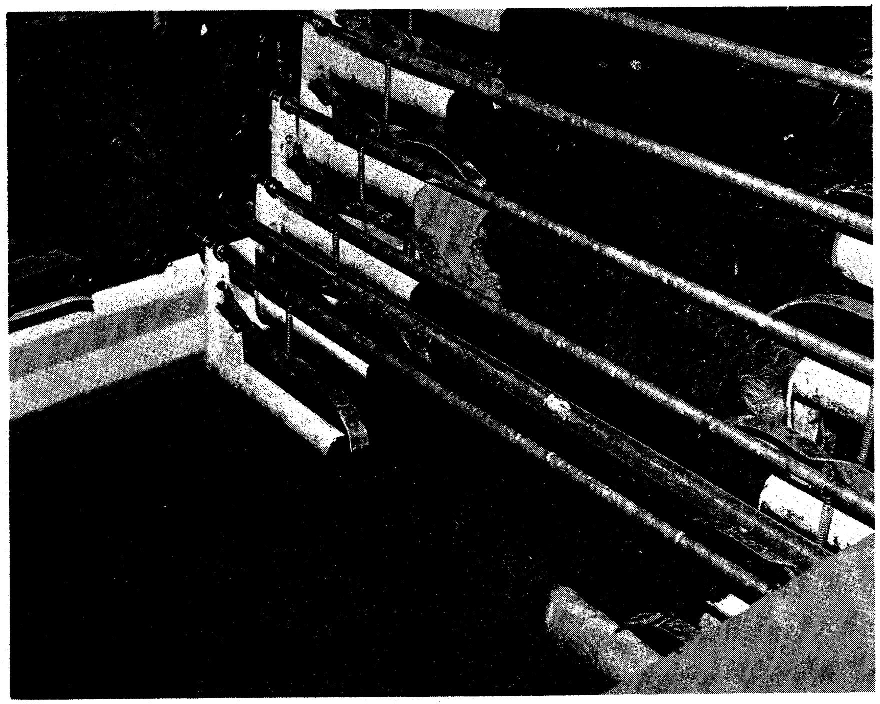

FIGURE 3. — Hides entering soaking vat #2 while draped over bars.

Mechanical Unhairing and Fleshing. On conveyor #2, the hides are firmly held by bar clamps and are fully suspended from their butt ends as they move to the open unhairing machine #1. Each hide is lowered into this machine until the low point of travel is reached, at which time the machine closes automatically and the lower half of the hide is unhaired as the conveyor withdraws it (Figure 4). Next, the hide is lowered into an open fleshing machine where the hide is refleshed in similar fashion. The feed-out of both machines exceeds the speed of 30 fpm of the conveyor, resulting in unhairing and fleshing operations similar to those from manually operated machines.

In a flip-over station, the hides are now transferred to hide transport conveyor #3 where they are automatically clamped on their neck ends, so that their butt end halves can be unhaired and fleshed in a duplicate machine arrangment. Thus fully unhaired and fleshed, the hides are ready for automatic splitting.

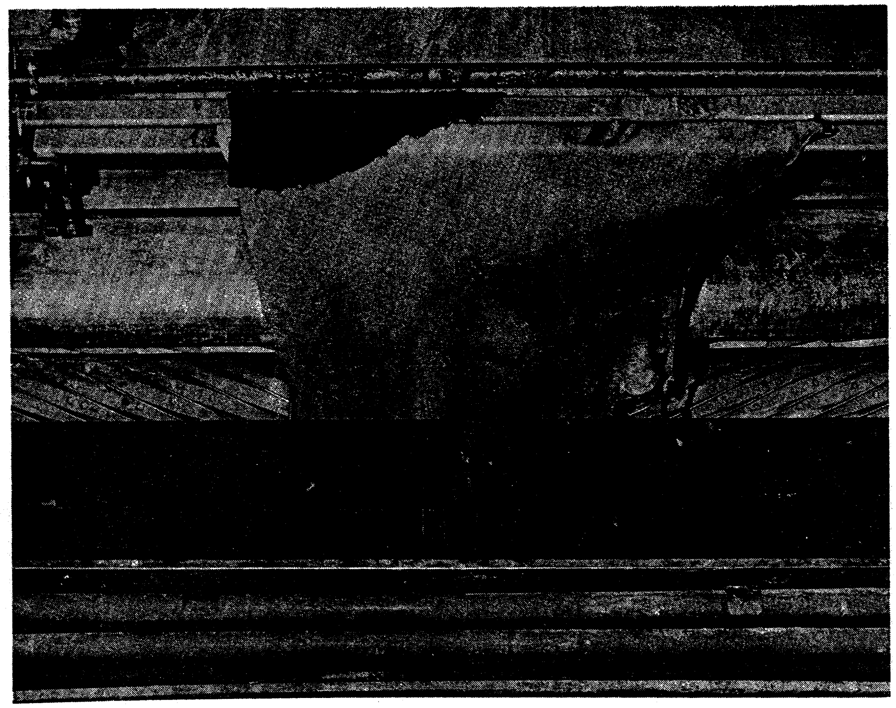

FIGURE 4. — Hide in the unhairing machine while clamped on its butt end.

SPLITTING. Automatic splitting has gone through many phases of development, resulting in a number of marked improvements to splitting machinery. The initial concept of automatic splitting envisioned the machine being turned on its side into a vertical configuration. This provides ease of feeding from an overhead transport conveyor carrying the hides clamped on one end as required for the fleshing and unhairing operations. At the same time, this arrangement makes use of gravity for assisting the feed mechanism to present the leading hide edge to the nip of the splitter, and to permit the splits to drop from the machine. (See Figures 5 and 6 which depict the hide during the initial splitting phase after it is released from the overhead conveyor.)

A cradle was designed to rigidly support a reconditioned 6-ft Turner* band knife hide splitting machine turned on its side. Then a feed mechanism was designed to convey the hides wrinkle-free to the splitter. After the splitter with modified bearings was mounted in the cradle, trials were made by manually feeding and splitting the hides to demonstrate that "vertical" splitting could be accomplished. Subsequent tests with the automatic feeder/splitter combination

*Reference to brand or firm name does not constitute endorsement by the U.S. Department of Agriculture over others of a similar nature not mentioned.

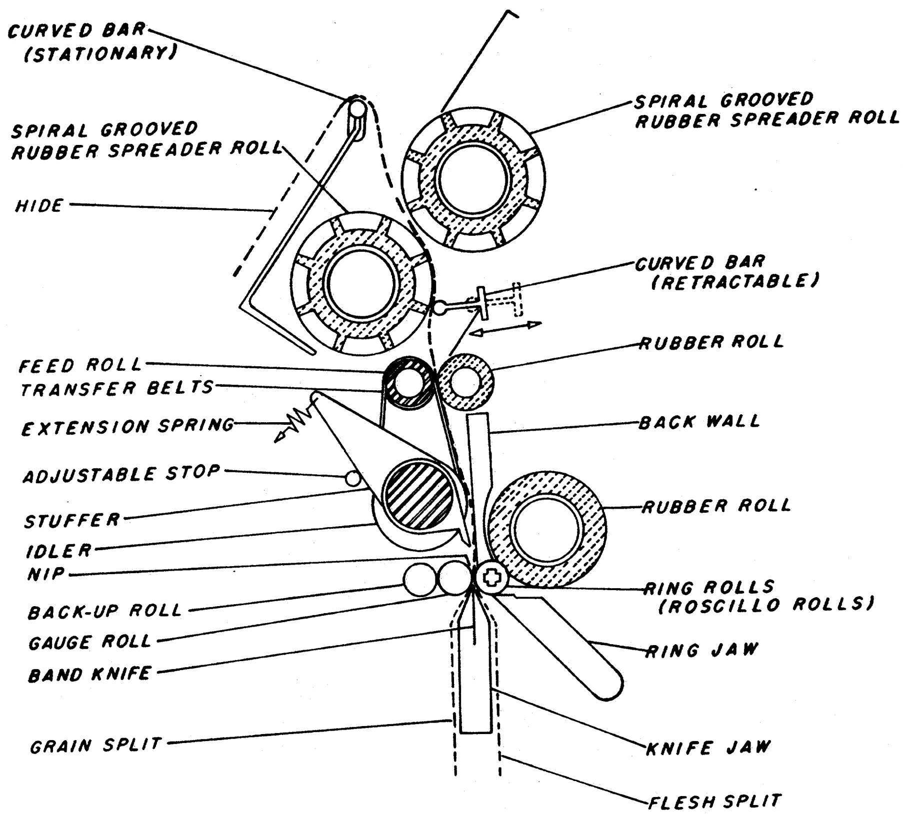

FIGURE 5. — Schematic cross-section of the splitter/feeder.

showed that while the feeder fed the leading hide edge quite well, it overfed the trailing hide portion, resulting in many wrinkles and subsequent jams. Adding automatic clutches operated by an electric eye to both spiral feed rolls alleviated the overfeeding, but did not solve the wrinkle problem because a large and variable amount of slippage persisted in the nip of the splitter. Increasing the no-slip splitter speed from its original 28.5 fpm to 36.8 fpm helped, but again did not consistently solve the wrinkle problem. Torque limiters were added to the feed mechanism and adjusted to allow for positive feeding of the leading hide edge. As soon as the hide is caught in the nip of the splitter, the feed mechanism stops and the splitter must pull the hide through the feeder against the hold-back force provided by these torque limiters. Curved bars at two locations on the feeder help to prevent wrinkles from forming. This, however, has slowed down the splitter. Operation of the feeder in an intermittent mode can control the build-up of wrinkles and avoid jams in the splitter.

The feeder is also equipped with stuffers. Operating close to the nip of the splitter, these stuffers move on an eccentric shaft. A spring holds these stuffers against an adjustable stop preventing them from hitting the back wall, but allowing them to feed varying hide thicknesses to the nip. As soon as the splits appear below the splitter knife support, the stuffing action is halted and the eccentric shaft is stopped with the stuffer edges against the hide. This provides for additional leveling of the hide just before it enters the nip.

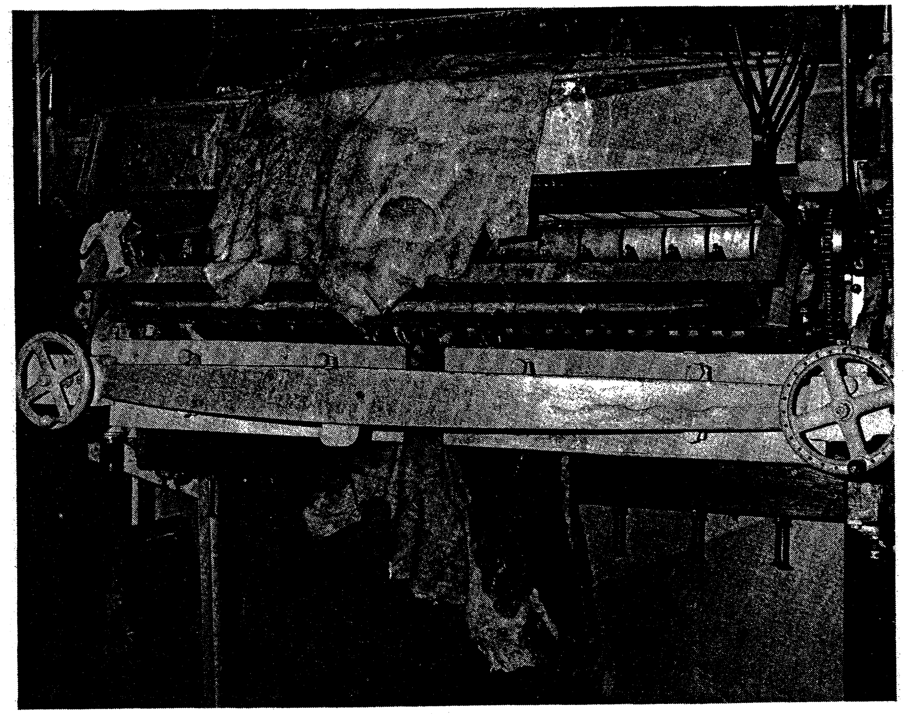

FIGURE 6. — Hide in the splitter/feeder.

Originally, our splitter was equipped with a standard ring roll assembly driven by a rubber roll. With the splitter on its side, consecutive splitting attempts gave inconsistent results and often failed completely. It was then discovered that the ring rolls stopped turning after the rubber roll had become wet while splitting the first hide. This problem, well known by tanners who split "in the lime," is aggravated when the splitter is turned on its side and the rings no longer rest on the rubber roll. Installation of a positively-driven ring roll assembly (Roscillo rolls) and matching drive attachment corrected this problem. Subsequently, the overrunning clutch on the drive attachment was replaced with a torque limiter in order to prevent mechanical damage to this unit should a hide jam in the nip.

THE PILOT-PLANT LINE. In order to test and develop the key components of the continuous beamhouse, a pilot-plant line for the wet-end processing of sided, brined cattlehides was designed, fabricated, and installed. Except for the transfer device between conveyors #1 and #2, the pilot-plant line is complete. When compared to the previously described proposed production line (Figure 1), this line uses shorter vats, three groups of six hide carrier bars, one unhairing and one fleshing machine, no flip-over device, and no conveyor #3.

In order to provide more than 3 min for each soaking and for the unhairing step, conveyor #1 is stopped as required while each group of six hides is fully submerged in one of the three vats. Agitation of the hides takes place whether the conveyor is running or stopped. After the hides are unhaired and refleshed on their neck ends, the automatic opening of the clamps of conveyor #2 at the splitter causes the hides to drop into a container. They are then returned to the transfer station and manually presented to the clamps of conveyor #2. Unhairing and refleshing, utilizing the same two machines, is repeated for the butt ends. As these clean hides now arrive at the splitter, they are automatically fed to its nip and split (Figure 6).

Discussion

The two main conveyors with their hide carriers or clamps have been tested and work well. The feed conveyor in conjunction with the loading station of conveyor #1 is operational. Personal safety equipment has been purchased, a hydrogen sulfide detector and warning system was installed, the safety training of operating personnel has been completed, and all vats have been filled. A number of test runs have validated the soundness of the mechanical design, and research on chemical processing variables is now underway.

Limited tests with the unhairing and fleshing machines indicated the need for a hide spreading device. This device is now ready for installation and testing. The device for transferring the hides from conveyor #1 to conveyor #2 is in the initial design concept phase.

In the meantime, development of the automatic feeder/splitter continues. Observations during automatic splitting have shown that despite earlier feeder/splitter modifications and improvements, wrinkles will occur. While small wrinkles merely cause the splitter to "slow down" (reducing the throughput speed), large wrinkles lead to a jam. For this reason, any fixed feed velocity will sooner or later lead to a jam of the splitter. An operator, by carefully observing small wrinkles as they form, can stop the feeder and restart it after the splitter recovers and the wrinkles have disappeared, thereby preventing jams. Finally, in order to meet the objectives of the automated line, a device for detecting the strain on the splitter will be incorporated. This device will provde the feedback needed to control the feed velocity to the splitter and prevent wrinkles.

Conclusions

The work described was planned to be accomplished in three stages: 1. Obtain the experimental data for designing the line; 2. fabricate and install all components of the line and conduct shake-down tests of all mechanical components; 3. demonstrate the commercial feasibility of the process.

The first two stages are essentially completed. The third and last phase is now in progress. Automatic equipment for the continuous rapid unhairing of brined cattlehides has been developed. A conveyor system with clamps capable of transporting hides through mechanical unhairing and refleshing, utilizing conventional unhairing and fleshing machines, has been designed. A hide splitting machine turned on its side has been equipped with a feeder aimed toward developing a means for automatic splitting. While rapid unhairing and automatic fleshing work quite well, automatic splitting requires additional development work.

NOTE: Fully detailed fabrication and assembly drawings for both hide transport conveyors, the feed conveyor with its platform, the three vats, and the hide clamps of conveyor #2 are available and may be requested by writing to the authors.

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